

Transient Atmospheric Flows and Disturbances

Chapter 7

Impact of Storms on the Landscape

- Storms influence our lives everyday
- Storms impact the landscape
 - Negative effect
 - Accelerate erosion,
 - Flood valleys,
 - Destroy buildings
 - Decimate crops
 - Positive effect
 - Promote diversity in vegetative cover
 - Increase the size of lakes and ponds
 - Stimulate plant growth with moisture
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Air Masses

- Characteristics
 - Must be large
 - More than 1000 miles across and several miles deep
 - Must have uniform properties in the horizontal dimension
 - Must be a recognizable entity and travel as one
 - Origin
 - Develops its characteristics by remaining over a uniform land or sea surface long enough to acquire the **temperature, humidity, and stability** characteristics of the surface.
 - The air is usually **stable stagnate air**
 - Form in anti-cyclonic conditions called source regions
 - Ideal regions are ocean surfaces and extensive flat land areas that have a uniform covering of snow forest, or desert. (Page 180 for Picture)
- Classification
 - **Arctic/Antarctic A** Antarctica, arctic Ocean and fringes, and Greenland
 - Very Cold, Very Dry, Very Stable
 - **Continental Polar cP** High-latitude plains of Eurasia and North America
 - Cold, dry, very stable
 - **Maritime Polar mP** Oceans in vicinity of 50 – 60 latitude
 - Cold, moist, relatively unstable
 - **Continental tropical cT** Low-latitude deserts
 - Hot, very dry, unstable
 - **Maritime tropical mT** Tropical and subtropical oceans
 - Warm, moist, or variable stability
 - **Equatorial E** Oceans near the equator
 - Warm, very moist, unstable
- North American Air Masses

Fronts

- Boundary between a two unlike air masses
- Not two dimensional boundary at the surface, but a three dimensional zone of discontinuity
 - **Warm, cold, stationary, occluded fronts**

Warm Fronts

- Forms by advancing warm air
- Slope is gentle, ascends over retreating cool air, decreasing adiabatically as the air rises
- Clouds form slowly and not much turbulence (High cirrus clouds, moving towards a altocumulus or altostratus)
- Broad precipitation, protracted and gentle
- If unstable air, precipitation can be showery or violent.

Cold Fronts

- Forms formed by advancing cold air
- Is a steeper front than a warm front with a “protruding nose”
- Moves faster than a warm front
- Rapid lifting, unstable air, blustering and violent weather
- Vertically developing clouds
- Precipitation along the leading edge and immediately behind the ground-level position of the front.
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Stationary and Occluded Fronts

- Stationary front – gently rising warm air, limited precipitation
- Occluded front – when a cold front overtakes a warm front.

Atmospheric Disturbances

- Midlatitude Disturbances – midlatitude cyclones and anticyclones
- Tropical Disturbances – monotonous, same daily, monthly, yearly. Tropical cyclones (hurricanes or cyclones on easterly waves)
- Localized Severe Weather
 - Thunderstorms and tornadoes.

Midlatitude Cyclones

- Characteristic
- Diameter – 1000 miles or so
- Ground level center pressure 990 – 1000 millibars
- Clear-cut pressure trough extends southwesterly from the center
- Counter-clockwise circulation pattern in the Northern Hemisphere
- Two fronts, warm and cold, with a cool sector north and west of the center and warm sector to the south and east.

- Clouds – cumuliform clouds yield shower precipitation , originates in the warm air rising about the fronts and falls down through the front to reach the ground in the cool sector
- Passing of the Front
 - Temperature decreases sharply
 - Winds shift from southerly ahead of the front to the northwesterly flowing it
 - The front is in a pressure trough, so pressure falls as the front approaches and rises after it passes
 - Clear skies are replaced by cloud cloudiness and precipitation of the front
 - Similar changes but to a lesser magnitude occur when the warm front passes
- Movements
 - Generally move west to east. Taking about 3 to 4 days to cross the US
 - System has a cyclonic wind circulation with converging counterclockwise from all sides
 - Cold front normally advances faster than the storms moves swinging ii counterclockwise around the pivot center increasingly moving and displacing the warm sector
 - Warm front usually advances more slowly than the storm

Life cycles of Midlatitude Cyclones

- **Cyclogenesis**
 - Develop in 3 to 6 days to maturity, and about the same length to dissipate
 - Start as “waves” or wave cyclone along the polar front.
- **Occurrence and Distribution**
 - At any given time from 6 to 15 midlatitude cyclones exist in the Northern Hemisphere
 - Occur at scattered but irregular intervals through the zone of the westerlies.
- **Front develops**
- **Wave appears along the front**
- **Cyclonic circulation is well developed**
- **Occlusion begins**
- **Occluded front is fully developed**
- **Cyclone dissipates**

Midlatitude Anti-cyclones – High Pressures

- Characteristics
- High pressure – has air converging into it from above, subsiding, and diverging at the surface, clockwise rotation.
- No air-mass conflict or surface convergence is involved
- No fronts involved
- Weather clear and dry with little or no opportunity for cloud formation
- Wind movement very limited near the center, increases progressively outward
- Very low temperatures in the winter
- Prone to stagnate and remain over the same region for several days

Minor Tropical Disturbances: Easterly Waves

- Long but weak migratory low-pressure system
- Occurs between 5 to 30 of latitude
- Tropical disturbances
 - Hurricanes, typhoons, baguios, or cyclones
 - Develop from incipient low-pressure perturbations in trade-wind flow, called tropical disturbances.
 - Tropical depression – wind speed of less than 38 mph but has closed wind circulation pattern
 - Tropical Storm– winds between 39 to 73 mph
 - Hurricanes – winds greater than 74 mph

Hurricanes

- Characteristics
 - Prominent low-pressure centers that are essentially circular with steep pressure gradient outward from the center
 - Converging cyclonic wind pattern “fuel” that powers the storm
 - Warm, water vapor-laden air spirals into a storm
 - Intense updrafts within towering cumulonimbus clouds
 - Eye of the Hurricane, walls of rain bands
- Origin
 - Form only over warm oceans in the tropics at least a few degrees north or south of the equator
 - Mechanism of formation not fully understood
 - Always develop out of a preexisting disturbance in the tropical troposphere.
 - Easterly waves provide low-level convergence and lifting that catalyze the develop
 - Less than 10% of all easterly waves grow into hurricane
- Movement
 - Stay within the trade-winds moving east to west.
- Damage and Destruction
 - Saffir-Simpson Hurricane Scale 1-5 in intensity
 - Storm Surge -- Ocean bulge – wind driven water that pounds into a shoreline

Localized Severe Weather

- Thunderstorms
 - Defined as a violent convective storm accompanied by thunder and lightning
 - Found frequently found in conjunction with other kinds of storms
 - Triggered by unstable uplift
 - Formation called the cumulus stage
 - Mature stage – in which updrafts and downdrafts coexist as the cloud continues to enlarge – heavy rain accompanied with hail, blustery winds, lighting, and the growth of the anvil top
 - Dissipating stage -- with light rain ending the turbulence.

Tornadoes

- Very small and localized
- Most destructive of all atmospheric disturbances
- Most intense vortex in nature, deep low pressure cell surrounded by a violently whirling cylinder of wind
- Less than a quarter of a mile in diameter but most extreme pressure gradients known (100-millibar difference from the center to the edge.
- Upswept water vapor condenses into a funnel cloud
- Advances along an irregular track that generally extends from southwest to northeast in the US
- Fujita tornado intensity scale for intensity
- Formation – develop in the warm moist unstable air associated with a midlatitude cyclone, along the squall line
- Develops out of mesocyclone, but only about half of all mesocyclones formed result in a tornado
- More than 90 % of tornadoes happen in the US in Tornado Alley